

## CLAIMS

### What is claimed is:

1. A high density multi-layer microcoil comprising:
  - a substrate;
  - 5 a multi-layer coil winding, formed on said substrate, composed of a plurality of coil element layers linking one another; two ends of said coil layers are contact points for outer circuits; and
  - a dry film photoresist structure, formed on said substrate and enclosing said multi-layer coil winding for supporting said coil winding.
- 10 2. A high density multi-layer microcoil according to claim 1 further comprises a magnetic core formed in an axis of said coil winding and parallel to said substrate.
3. A high density multi-layer microcoil according to claim 2 wherein said magnetic core is made of a material of high magnetic permeability.
4. A high density multi-layer microcoil according to claim 3 wherein said high magnetic 15 permeability material is chosen from supermalloy, which is composed of 79% nickel, 15% iron, 5% molybdenum and 0.5% manganese; high magnetic permeability alloy (78.5% nickel and 21.5% iron); iron and cobalt alloy, pure (99.96%) iron and silicon steel.
5. A high density multi-layer microcoil according to claim 1 wherein said dry film 20 photoresist is chosen from negative photoresist materials.
6. A high density multi-layer microcoil according to claim 1 wherein said dry film photoresist is SU-8.
7. A high density multi-layer microcoil according to claim 1 wherein said dry film

photoresist is chosen from high strength materials.

8. A high density multi-layer microcoil according to claim 1 wherein said coil winding is made of conductive materials with low melting point.
9. A high density multi-layer microcoil according to claim 1 wherein said coil winding is  
5 made of lead and tin alloys.
10. A high density multi-layer microcoil according to claim 1 wherein each coil element comprises at least two windings.
11. A process for fabricating a high density multi-layer microcoil comprising steps of:
  - providing a substrate;
- 10 using photolithography process to form a dry film photoresist structure with a coil tunnel having coil elements perpendicular to said substrate and two outlets at ends of said tunnel; and
- injecting a conductive material with low melting point into said tunnel and forming a coil winding.
- 15 12. A process for fabricating a high density multi-layer microcoil according to claim 11 wherein said steps of forming said photoresist structure depend on number of windings in each coil element; for a coil element with N windings, said windings are numbered as 1 to N from inner to outer; each coil winding is composed of a top parallel portion, a bottom parallel portion and two vertical portions and formed as a planar coil element  
20 perpendicular to said substrate; said photoresist structure is made by  $4N+1$  times of deposition, comprising steps of:
  - depositing first to  $2N$ th photoresist materials, using photolithography to form said lower half portions of said 1 to N windings of said coil elements; said lower half portions comprises bottom parallel portions and lower halves of vertical portions;

depositing  $2N+1$  to  $4N$ th photoresist materials, using photolithography process to form said upper half portions of said  $N$  to 1 windings of said coil elements; said upper haft portions comprises upper halves of vertical portions and top parallel portions; and

depositing last ( $4N+1$ ) photoresist material, using photolithography to form a top of  
5 said photoresist structure.

13. A process for fabricating a high density multi-layer microcoil according to claim 12 wherein said dry film photoresist is chosen from high strength materials.
14. A process for fabricating a high density multi-layer microcoil according to claim 11 wherein said coil winding is made of conductive materials with low melting point.
- 10 15. A process for fabricating a high density multi-layer microcoil comprising steps of:
  - providing a substrate;
  - using photolithography process to form a dry film photoresist structure for a lower half coil tunnel;
  - depositing an insulation layer on top of said lower half coil tunnel;
  - 15 using photolithography process to form a magnetic core on said insulation layer and in center portion of said photoresist structure;
  - removing said insulation layer;
  - 20 using photolithography process to form a dry film photoresist structure for an upper half coil tunnel, which covers said magnetic core, and forms a coil tunnel having coil elements perpendicular to said substrate and two outlets at ends of said tunnel; and
  - injecting a conductive material with low melting point into said tunnel and forming a coil winding.
16. A process for fabricating a high density multi-layer microcoil according to claim 15

wherein said steps of forming said photoresist structure of lower and upper half coil tunnels depend on number of windings in each coil element; for a coil element with N windings, said windings are numbered as 1 to N from inner to outer; each coil winding is composed of a top parallel portion, a bottom parallel portion and two vertical portions and formed as a planar coil element perpendicular to said substrate; said photoresist structure is made by  $4N+1$  times of deposition, comprising steps of:

5 depositing first to  $2N$ th photoresist materials, using photolithography to form said lower half portions of said 1 to N windings of said coil elements; said lower half portions comprises bottom parallel portions and lower halves of vertical portions;

10 depositing  $2N+1$  to  $4N$ th photoresist materials, using photolithography process to form said upper half portions of said N to 1 windings of said coil elements; said upper half portions comprises upper halves of vertical portions and top parallel portions; and

depositing last ( $4N+1$ ) photoresist material, using photolithography to form a top of said photoresist structure.

15 17. A process for fabricating a high density multi-layer microcoil according to claim 16 wherein said dry film photoresist is chosen from high strength materials.

18. A process for fabricating a high density multi-layer microcoil according to claim 15 wherein said coil winding is made of conductive materials with low melting point.

20 19. A process for fabricating a high density multi-layer microcoil according to claim 15 wherein said magnetic core is made of high magnetic permeability materials.

20. A process for fabricating a high density multi-layer microcoil according to claim 15 wherein said magnetic core is made of materials chosen from silicon dioxide and silicon nitride.